PRODUCTIVITY PARADOX IN POLISH FOOD PRODUCTION INDUSTRY

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This paper presents the results of studies of the relationship between level of advancement of IT solutions used in Polish enterprises of food processing and the company's financial situation, logistic costs, position on the market against the sector, and quality of IT support of logistics. The results showed no significant correlation between IT solutions advancement level and financial situation, and logistic costs. These results corresponds with the productivity paradox signaled in the literature. However, there was an average correlations between the IT solutions advancement level and position on the market against the sector, and quality of IT support of logistics. The studies used the results of a survey conducted in 2009-2011 among Polish food processing sector enterprises.

Keywords: IT investments, company's performance, productivity paradox, food production

1. Introduction

To improve their performance, different organizations, especially commercial companies are investing more and more money into information technology (IT). Many research results indicates on increasing trend of IT investments in recent years. Despite the rapid growth of IT investments, it has no explicit confirmation of relationship between IT investments level and business performance indicators. In consequence, questions about the existence of direct effect of investment on the

financial results of enterprises and the possible strength of such relationship (Henderson et al., 2010) (Lim et al., 2011) (Masli et al., 2011) (Khalaf, 2012). This problem is not new. Already in the first half of the 90 years of XX century, on the basis of the results of studies in many companies in the U.S. and Europe, a famous American economist, Paul A. Strassmann said: "You're looking for a direct relationship binding expenditure on computerization of business profits? Forget about it.". Another eminent American economist and Nobel Prize winner in 1987, Robert Solow said: "Computers can be seen everywhere, except efficiency statistics." (Badurek, 1998). Just then in the literature a term of productivity paradox was began to be used for determining of described lack of association (Strassman, 1990) (Brynjolfsson, 1993) (Loveman, 1994).

IT investments are made based on the assumption that they have the potential to improve both the efficiency of business processes and competitive advantage. These investments can be internal or external. Internal IT investments aimed at reducing business costs, improve quality and speed, eliminating repetitive business processes and increase business agility. Externally focused IT investments are planned to help the company gain a sustainable competitive advantage and improve its market position, particularly by improving customer satisfaction.

There have been many studies that have attempted to assess the impact of IT investments on the financial performance of companies. Berndt & Morrison (1994) showed a negative impact of IT investments on the company's financial condition. In turn Bharadwaj (2000) and Kim et al. (2009) showed that IT investments have a positive impact on the company's financial condition. However, Melville at al. (2007) showed that the impact of IT investments on the financial condition depends largely on the branch. The study was conducted on a similar issue in Poland. Kaminski and Kulisiewicz (2007) conducted a survey and tested a total of 540 Polish companies from the SME (Small and Medium Enterprises) sector. On the basis of the results conducted studies, they put forward a proposal that among Polish companies belonging to small and medium-sized enterprises it is difficult to assess the impact of IT investments on the company's financial condition. The obtained results shown on the Figure 1 and Figure 2, are ambiguous.

In contemporary information society and electronic commerce, information technology plays a key role, acting in the most efficient means of achieving, transfer and process information. Therefore, informatization concerns in principle to all sectors of the economy, even those in which traditional IT technologies are used in a very limited extent for example in agriculture and agribusiness, especially in food processing and production. Modern enterprises producing foods are characterized by complex logistic chains functioning in accordance with the principle of "from the farm to the fork", as well as extensive connections including many different kinds of co-operation partners: providers of agricultural products, suppliers of intermediate

products and recipients of food products. This is also the case in the Polish sector of the food processing industry (Jałowiecki i Jałowiecka, 2013).
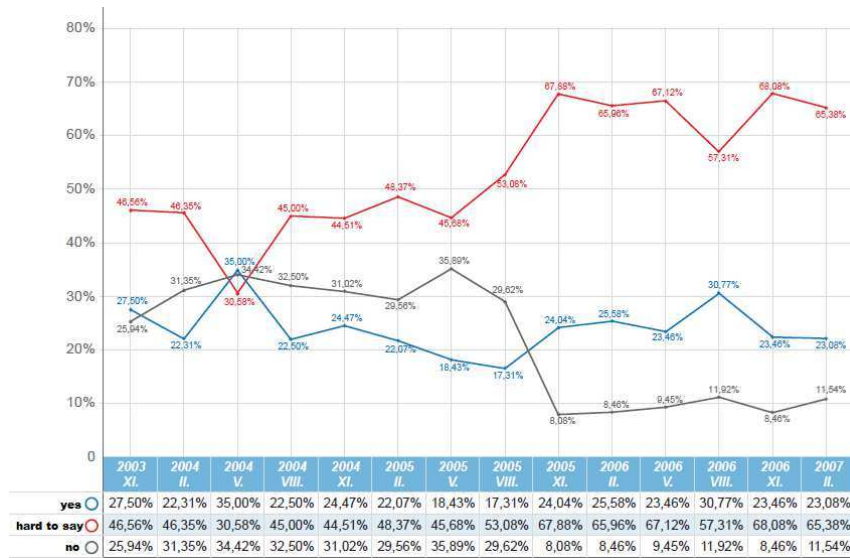

	2003 XI.	2004 II.	2004 V.	2004 VIII.	2004 XI.	2005 II.	2005 V.	2005 VIII.	2005 XI.	2006 II.	2006 V.	2006 VIII.	2006 XI.	2007 II.
yes	27,50%	22,31%	35,00%	22,50%	24,47%	22,07%	18,43%	17,31%	24,04%	25,58%	23,46%	30,77%	23,46%	23,08%
hard to say	46,56%	46,35%	30,58%	45,00%	44,51%	48,37%	45,68%	53,08%	67,88%	65,96%	67,12%	57,31%	68,08%	65,38%
no	25,94%	31,35%	34,42%	32,50%	31,02%	29,56%	35,89%	29,62%	8,08%	8,46%	9,45%	11,92%	8,46%	11,54%

Figure 1. Is the last quarter of IT equipment (hardware and software) has contributed to the company's revenue? Source: *Kamiński and Kulisiewicz (2007)*

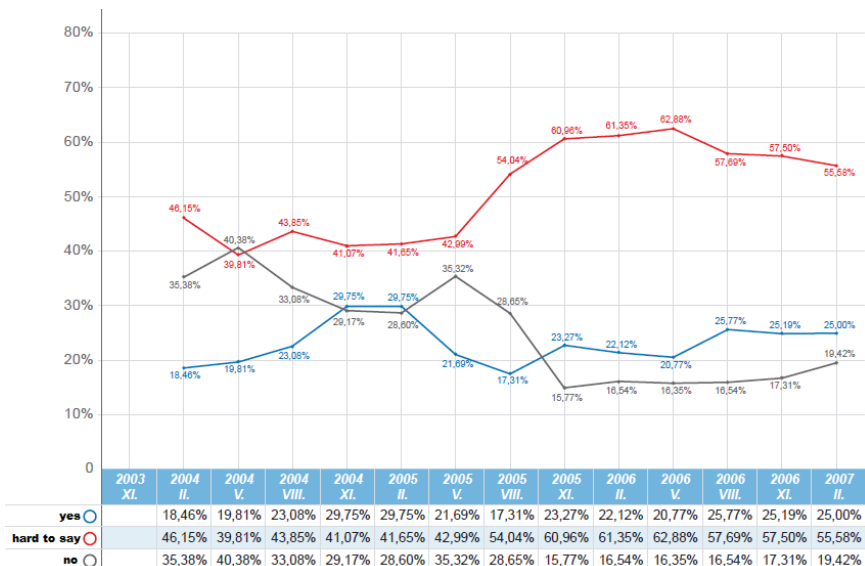|	2003 XI.	2004 II.	2004 V.	2004 VIII.	2004 XI.	2005 II.	2005 V.	2005 VIII.	2005 XI.	2006 II.	2006 V.	2006 VIII.	2006 XI.	2007 II.
yes		18,46%	19,81%	23,08%	29,75%	29,75%	21,69%	17,31%	23,27%	22,12%	20,77%	25,77%	25,19%	25,00%
hard to say		46,15%	39,81%	43,85%	41,07%	41,65%	42,99%	54,04%	60,96%	61,35%	62,88%	57,69%	57,50%	55,58%
no		35,38%	40,38%	33,08%	29,17%	28,60%	35,32%	28,65%	15,77%	16,54%	16,35%	16,54%	17,31%	19,42%

Figure 2. Is the last quarter of IT equipment (hardware and software) helped to reduce the company's costs? Source: *Kamiński and Kulisiewicz (2007)*

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In consequence, information technology support of activities such enterprises is primarily concerned on logistics and information management, and the complexity of information systems should be fairly high. This in turn causes that the cost of such systems implementation are quite high. Additionally, in Poland, the vast majority (98.9%) of food producing sector enterprises represent those belonging to the SME sector, among which the vast majority (69.7%) are micro-enterprises employing up to 9 persons, inclusive. For obvious reasons, small enterprises have limited financial capacity, so the acquisition and implementation of integrated information systems can be problematic (Wicki i Jałowiecki, 2010). The advancement level of IT technologies and complexity level of information systems used to support both logistics and information management in Polish agribusiness enterprises is relatively low. The main focus is on the information processing and exchange with business partners rather than internal circuit. Quite large differences were also found between the different sectors (Jałowiecki, 2012a) (Jałowiecki, 2012b). In previous studies, a correlation was found between the IT solutions advancement level and position of the enterprise against the branch was found. Although this relationship was shaped at an average level, it was statistically significant. It was also found that the strength of this relationship was the greater, the greater were surveyed companies (Jałowiecki and Gostkowski, 2012).

2. Aim, scope and methods

The main aim of the studies was to examine the correlation between advancement level of IT solutions used in polish agri-food companies and company's performance indicators: financial situation, level of logistic costs, position on the market, and quality of IT support of logistics. Source data came from a survey conducted in 2009-2011 among enterprises of the agro-food industry. As a result of the survey obtained responses from 512 companies. In the individual studies only those companies which have identified its employment size category and performance indicators in the surveys, were taken into account. The study group was divided into four subgroups depending on the number of employees in company: microenterprises (up to 9 employees), small (from 10 to 49 employees), middle (from 50 to 249 employees), and large enterprises (250 and more employees). To assessment of used IT solutions advancement level, indicator proposed by Jałowiecki and Jałowiecka (2013) was used. It is based on six components:
- the fact of having a comprehensive information system (1 point for answer "yes", 0 points for answer "no");
- IT support of five areas of logistics: transport, stocks, packaging and reverse logistics, storage management, order management and forecasting (0.2 points for every answer "yes");

- method of information transfer in internal circuit (0 – declared any way, 0.17 – verbally, 0.33 – on paper, 0.5 – by phone, 0.67 – by fax, 0.83 – by e-mail or Internet communicator, 1 – in software);
- method of information transfer in external circuit (0 – declared any way, 0.17 – verbally, 0.33 – on paper, 0.5 – by phone, 0.67 – by fax, 0.83 – by e-mail or Internet communicator, 1 – in software);
- proficiency level of used information system (0 – declared any system, 0.2 – Financial-Accounting (FA) system, 0.4 – Electronic Data Interchange (EDI), 0.6 – Materiel Resources Planning (MRP) system, 0.8 – Enterprise Resources Planning (ERP) system, 1 – Business Intelligence (BI) system);
- method of building and using of forecasts (0 – declared absence of formal forecasts, 0.2 - production depending on the raw material supply, 0.4 – production based on orders received, 0.6 – forecasts based on historical data only from the company, 0.8 – forecasts based only on data from market studies, 1 - forecasts based on data from the company and market data, including also market forecasts).

The values of this ratio are in the range of 0 to 6 and was categorized into five categories: very low, low, average, high and very high, by the fact that its component variables assume the values categorized.

To assess the strength of the correlation between variables and the stage used solutions used Spearman's rank correlation coefficient:

$$r_S = 1 - \frac{6 \cdot \sum_{i=1}^{n} d_i^2}{n^3 - n}, \qquad \text{where} \qquad d = (x_i - y_i)^2.$$

Hipothesis: $\begin{matrix} H_0: & r_S = 0 \\ H_1: & r_S \neq 0 \end{matrix}$, test statistic: $t = \dfrac{r_S}{\sqrt{\dfrac{1 - r_S^2}{n-2}}}$,

where: i – company number, x_i – researched variable category, y_i – indicator of IT solutions advancement category, n – number of enterprises, t – test statistic about t-Student distribution.

For using Spearman's rank correlation coefficient suggests that there is a logical sequence of enterprises if we consider those companies with variable depending on the test. The financial situation of the company takes four possible values: very bad, quite bad, rather good, very good, and logistics-related costs in the total cost adopt the following categories: very high, rather high, rather low, and very low participation. The company's position in the market against the sector was categorized on four categories: very weak, rather weak, rather strong, and very

strong. The last studied company's performace indicator – the quality of IT support of logistics has also four possible values: very poor, rather poor, rather good, and very good.

3. Results

As mentioned Polish sector of the food processing industry is characterized by a great diversity both in terms of industry branch, as well as due to the volume of employment. Figure 3 shows the percentages of the enterprise groups that responded to the survey in division according to employment size category.
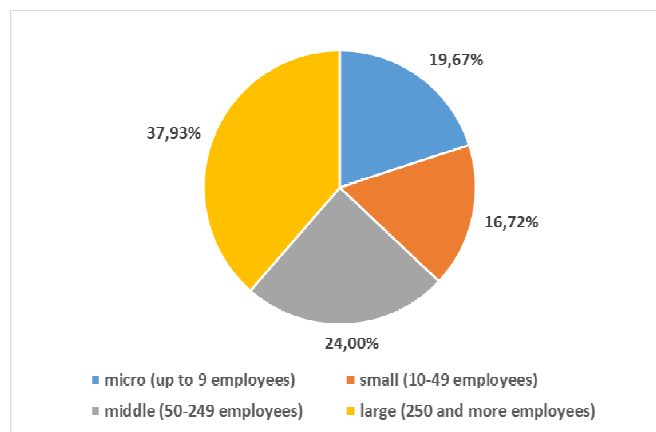

Figure 3. The structure of the survey sample of Polish food-producing enterprises used in research

On the basis of the Spearman correlation coefficient, no correlation between the IT solutions advancement level, and the financial situation was found in all enterprises (Table 1). The results confirm prior literature.

Table 1. Results of Spearman's rank correlation between IT solutions advancement level and financial condition for all companies surveyed
(significance level α = 0.05)

r_s	t	p-value	t_α
0.05	1.16	0.25	1.97

The analysis of this relationship in different subgroups of enterprises indicated the absence of statistically significant correlation in all groups except for small enterprises (Table 2). The results of previous studies indicate that it is an enterprise group, which is mainly used for basic autonomous financial and

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accounting systems, often based on commonly available spreadsheets such as Microsoft Excel (Jałowiecki, 2012a).

Table 2. The values of Spearman's rank correlation between IT solutions advancement level and financial condition depending on the size class of the company (significance level $\alpha = 0.05$)

size class of company	r_s	t	p-value	t_α
micro	0.07	0.59	0.59	2.00
small	0.16	2.92	<0.01	1.97
middle	0.06	0.59	0.56	1.98
large	0.02	0.12	0.90	2.05

Statistically significant, but very weak average level of correlation was found between the level of used IT solutions, and participation of logistics costs in total operating costs for all companies (Table 3). It was a positive correlation, which means that, paradoxically, a higher level of advancement of used IT systems meant higher costs of logistics.

Table 3. Results of Spearman's rank correlation between IT solutions advancement level and participation of logistics costs in total operating costs for all companies surveyed (significance level $\alpha = 0.05$)

r_s	t	p-value	t_α
0.17	3.72	<0.01	1,97

The results obtained in the different subgroups of enterprises indicate no statistically significant correlation in all groups also except for small enterprises. It was positive and weak correlation, which means that a higher level of advancement of IT systems is related to the higher level of logistics costs. Even only in the group of large enterprises was no correlation between higher advancement IT systems level and lower logistic costs level (Table 4).

Table 4. The values of Spearman's rank correlation between IT solutions advancement level and participation of logistics costs in total operating costs depending on the size class of the company (significance level $\alpha = 0.05$)

size class of company	r_s	t	p-value	t_α
micro	0.05	0.37	0.71	2.01
small	0.22	3.78	<0.01	1.97
middle	0.08	0.78	0.44	1.99
large	-0.01	-0.03	0.98	-2.06

The resulting deficiencies or very weak correlations between the level of advancement of IT solutions, and the financial situation of enterprises and logistics costs confirm reports in the literature. Taking into account generally undisputed positive impact the use of modern IT technologies on the companies functioning, in the next step correlations between the level of advancement of used IT solutions and market position the company against the sector and the quality of IT support logistics were investigated. In both cases there was a statistically significant and average strong correlations (Table 5 and 7).

Table 5. Results of Spearman's rank correlation between IT solutions advancement level and position in the market against the sector for all companies surveyed (significance level $\alpha = 0.05$)

r_s	t	p-value	t_α
0.32	7.53	<0.01	1.96

The results obtained in the different subgroups of enterprises indicate statistically significant correlations in all groups. Stronger correlations was found between the level of advancement of used IT solutions, and the quality of IT logistics supporting, than the company's market position. In both cases, correlations were getting stronger in groups of enterprises of increasing employment (Table 6 and 8).

Table 6. The values of Spearman's rank correlation between IT solutions advancement level and position in the market against the sector depending on the size class of the company (significance level $\alpha = 0.05$)

size class of company	r_s	t	p-value	t_α
micro	0.24	1.87	0.07	2.00
small	0.27	4.84	<0.01	1.97
middle	0.45	4.87	<0.01	1.99
large	0.55	3.26	<0.01	2.06

The results clearly indicate that with increasing size of the company, the transmission of modern IT technologies on the market position of the company is getting stronger.

Table 7. Results of Spearman's rank correlation between quality of IT support of logistics and IT solutions advancement level for all companies surveyed (significance level $\alpha = 0.05$)

r_s	t	p-value	t_α
0.44	10.18	<0.001	1.97

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Obtained results also indicate that despite the absence of direct correlation between the level of advancement of IT solutions, modern information technologies clearly influence the improvement of the market position of companies.

Table 8. The values of Spearman's rank correlation between quality of IT support of logistics and participation of logistics costs in total operating costs depending on the size class of the company (significance level $\alpha = 0.05$)

size class of company	r_s	t	p-value	t_α
micro	0.25	1.81	0.08	2.01
small	0.40	6.99	<0.01	1.97
middle	0.56	6.40	<0.01	1.99
large	0.70	4.88	<0.01	2.06

4. Conclusion

During the studies, a statistically significant correlation with average strength, according to which the increase in the number of employees in the company was accompanied by increase in the level of advancement used IT solutions was found in Polish agri-food production sector (Table 9).

Table 9. Results of Spearman's rank correlation between size of company's employment and IT solutions advancement level for all companies surveyed (significance level $\alpha = 0.05$)

r_s	t	p-value	t_α
0.51	13.20	<0.01	1.96

Further studies showed no correlation between the level of advancement of used IT solutions, and the financial situation of enterprises and its logistics costs. This confirmed reports in the literature known as the productivity paradox. The only exception were a small companies with 10 to 49 employees, which, together with an increase of level of advancement of IT solutions, it was very weak improvement of the financial situation and the very weak increase of the logistics costs. The question remains benefits generated by investments in IT solutions in the long term, and those that can not be directly translated into profit of company. These investments and, consequently, the level of IT technology modernity translates into higher market position of the company and better quality of logistics support. In the food industry, especially the latter correlation has an special

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importance because of the large number of very different categories of agricultural raw materials suppliers and consumers of food products, which significantly increases the complexity and complication level of logistic processes (Jałowiecki and Jałowiecka, 2013).

Considering a definite advantage for small and medium-sized enterprises in the Polish sector of food processing, it is worth noting limited possibilities of these companies for investment in modern IT technologies. In such a situation is particularly important opportunities for providing application services (APC), using on-demand software, or using software available in the cloud by SME sector. They can provide attractive and competitive offer for classic, expensive integrated information systems (MRP, ERP or BI).

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